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ABSTRACT

Information transfer measures hold the promise of being more useful than conventional, poorly identified, cost-benefit measures for evaluating scientific research programs. First, information transfer is one of the most significant activities engaged in by scientific research. Second, focusing on information transfer can provide substantial insight for the research program evaluator and administrator. Finally, focusing on information transfer measures requires thinking about the several interest groups and the different stages of research that are involved. A bibliography of 16 references is appended. (RAA)

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THE DEVELOPMENT OF
INFORMATION TRANSFER
MEASURES FOR THE
EVALUATION OF RESEARCH
PROGRAMS

by

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1. Introduction

I would first like to define some terms. The first is "research program." This refers to a set of related research projects which are funded and/or administered by a single public agency. By "research project" I mean organized investigative activities in areas such as the physical, natural, or social sciences which are not in most cases intended to design or develop specific, marketable products or services. The second term is "information transfer." This term is chosen instead of more general terms such as "knowledge transfer," "technology transfer," "dissemination" or "adoption of innovation" because of some of the definitional and measurement difficulties mentioned by Machlup (1979). Specifically, communication can only be said to have occurred when information transferred from one person to another results in an alteration in the state of knowledge of the recipient. As we will see, the difficulty in measurement of this phenomenon, so important when considering the evaluation of research programs from the public administrator's viewpoint, is one of the chief stumbling blocks in developing useful evaluation and performance measures.

2. Rationale for Development of Information Transfer Measures

The first question one might ask at this point is, why concentrate on information transfer measures when evaluating research programs? Isn't it much more meaningful to consider the costs and output of the programs and their ultimate impact on scientific advancement and their direct or indirect improvement of public welfare and the quality of life? Perhaps so, but realistically, we are faced with several difficulties if the latter view is adopted. The most obvious difficulty is that, especially with respect to government-funded research programs, it is usually impossible to identify a direct link between research and improved public welfare. Where such links can be identified, such as applied research to improve educational practice or to improve health care delivery systems, the ultimate measure of benefits is clouded by difficulty in measurement and in the cost of conducting convincing, longitudinal evaluative research.

A second difficulty is that, if we are to focus on a more intermediate goal such as the advancement of the state-of-the-art within a particular scientific

field or discipline, we are forced to come to terms with the difficult concept of "state-of-the-art." If we adopt Kuhn's concepts of scientific revolutions and research fronts, we see that the definition of what constitutes quality and innovation in research becomes highly dependent upon personal interpretation and judgment. The development of peer review systems (Cole, Rubin, and Cole, 1978; Cooper-Williams Associates, 1978) is the most successful method developed thus far to overcome this difficulty, although such systems are not without their detractors within the context of journal article refereeing (Gordon, 1977).

So, given the definitional and measurement difficulty concerning what constitutes "good" or "useful" research, let us examine some intermediate measures which describe how one of the most basic research resources, information, is produced and used. Measures such as publication output and citation analysis are already used for evaluative purposes (Lindsey, 1978; Narin, 1976). Perhaps we can put these measures into perspective as well as suggest additional measures.

3. Factors to Consider in Developing Evaluative Information Transfer Measures

There are several design factors which should be considered in developing information transfer measures for evaluating research programs.

First, the system of measures should take into account the variety of participants or interest groups which are involved in information transfer.

Second, the system of measures should consider not only the use of information but also how it is produced and transmitted. Related to this, the measures should also acknowledge the different types of information transfer that occur during the different stages of a research project.

Finally, and perhaps most difficult of all, the measures should take into account the importance of informal communication and its impact on how research is conducted.

Each of these factors are discussed in the following sections.

3.1 Interest Groups

There are at least five interest groups whose information transfer behavior is relevant to evaluating research program performance. These are:

1. Research performers
2. Other researchers
3. Policymakers
4. Funding agencies
5. General public

Each of these groups performs a somewhat different role regarding the research program. To understand the roles, it will help to think of each of them both as a potential generator and recipient of information.

Research performers

The traditional role of the research performer, of course, is to generate information. As discussed earlier, the research program administrator wants to ensure that the output of the program's individual projects advances the state-of-the-art and ultimately contributes to society. And the research performer also functions as a recipient of information. From the moment a research project is conceived through the time its results are published --- and even, perhaps, applied --- and the performer has shifted his or her attention elsewhere, the research performer should be on the constant lookout for relevant information and should be in a financial and organizational position to access such information.

Other researchers

How other researchers relate to other researchers, and vice versa, should also be of some interest to the program administrator. The performers themselves will have multiple allegiances outside the manager's funding agency, primarily the performer's employer and his or her peers. If, for example, the projects funded by an individual program are related to each other in some way, as is

often the case, it is to the program administrator's advantage for the performers to regularly share information among themselves as well as with other researchers in order to stimulate original thinking and avoid duplication. In many of the more traditional natural and physical sciences, this sharing of information among performers is already being provided for by traditionally-maintained formal and informal channels such as seminars, local and regional scientific meetings, and national conferences where research-in-progress can be discussed. Among less historical disciplines, or multidisciplinary programs which are problem-, rather than discipline-oriented, it may be necessary for program management to actively promote the transfer of information among performers and other scientists.

So we see that there are at least two levels of evaluation questions emerging here. The first concerns information transfer at the individual project level. The ability of the individual project to function effectively is at least partially dependent upon the capability of the project performers to effectively generate and use information. The second level is the program level. Those responsible for designing and managing the research program should not only be concerned with how information transfer is accomplished at the project level. In some cases program management should also consider how it can best promote information transfer among its research performers.

Policymakers

Another group which is relevant to the research program are policymakers, those who ultimately assign priorities for which areas are to receive research attention. At the Federal level this may be accomplished explicitly through legislative action requiring research. Or policymaking for setting research priorities may rest with individual agencies or even at the program level. Ordinarily, policymaking regarding government-supported research programs does not make explicit statements about information transfer behavior. Perhaps it is implicit in Federal agency research program policy that research activities will be accompanied by effective information transfer behavior. But this does not always appear to be the case, other than normal expectations that researchers will be aware of current literature and will disseminate their results via conferences and publications.

Those who promulgate research policy should be aware that, to a substantial degree, the success of their policies will be dependent upon the ability of the scientists whom they fund to successfully communicate their results to others. And this communication behavior is, for the most part, outside the control of both policy-making and program administration.

Funding agencies

The funding agencies themselves, especially the program administrators, have an important role to play in scientific information transfer. Through the mechanism of grants and contracts they potentially can control information transfer activities via funds for conferences, page charges, and other publication activities. But they also engage in significant amounts of communication themselves, chiefly through the mechanisms of planning documents, financial reports, monthly reports, and other internal program documentation. While in most cases the funding agencies can rely upon the research performers to disseminate their own results, they must often function as intermediaries between research producers and research users. When this involves the translation of research results into practical, applicable knowledge, the funding agency can play a very important role, especially when the research performers' priorities do not lie with the development of research applications. A good example of the role the funding agency can play in the dissemination of information -- and some of the pitfalls -- is provided by Raizen in her review of the information dissemination activities of the National Institute of Education (Raizen, 1979). That agency, and its multitude of programs, has taken its responsibility for disseminating research information to practitioners quite seriously. Raizen concludes, however, that results have been mixed. This seems at least partially due to numerous programs seemingly working at cross purposes. One of the lessons derived from NIE's experience which is relevant to how other funding agencies can promote the transfer of research information is that the funding agency must take into account the current information transfer practices of the communities it is serving. Based on studies of the process of innovation, this is not a surprising finding (Human Interaction Research Institute, 1976). Researcher-to-researcher information transfer is substantially different from researcher-to-practitioner transfer. The media and channels used for one may not be appropriate for another; failure to select correctly will ultimately doom the program, and this will not go unnoticed by the policymakers.

The public

The final interest group which the research program administrator should consider is the public, since we all eventually foot the bill for government-sponsored research. Naturally, the public at large is not likely to read scholarly academic journals nor attend national conferences. In fact, in Greenberg's words, the public might be considered to be scientific "illiterates" (Greenberg, 1967). In some cases public knowledge of research program activities is essential, as when the research which is performed is relevant to a particular public or professional constituency. But there may also be instances when knowledge gained through research can be directly beneficial to the public, as is the case of ongoing research concerning acid rain in the Northeast United States. This is an example where increasingly important public issues require the input of scientific information for effective debate.

3.2 Research Stages¹

Given all of these interest groups and their different information transfer behaviors, we now turn to the development of an evaluation framework. Its basic structure is based on (a) the idea that different types of formal and informal information are relevant to each of the interest groups just discussed, and (b) on the idea that types of information of interest also differ as to the particular stage of research being considered (e.g., see Garvey, Tomita, and Woolf, 1974; Allen, 1977).

There are numerous ways to describe the different stages of a research project. But for simplicity's sake, let us consider the following four generic stages:

1. Planning
2. Performance
3. Dissemination
4. Utilization

¹This section is based on: McDonald, Dennis D. (1979).

During the Planning stage, information is required chiefly by the researchers themselves and the funding agencies. In addition, research users, policymakers, and the public also have a potential need for research program information in order to participate in the planning process. The most important decisions which occur during the planning stage of research involve the selection of methodological or analytical approaches and the allocation of resources to specific research areas (in the case of policymakers and funding agencies) and to specific project components (in the case of research performers). Failure to consult appropriate information sources during the planning stage can result in wasted time, money, and other resources.

The role of information in research planning is partly anticipatory. Program managers or policymakers select areas for concentration partly in anticipation of future findings. Project staff select methodologies and individual problems in anticipation of proving or disproving hypotheses.

During the actual performance stage of research, however, the role of information is somewhat different. Scientific decisions are more closely related to practical research concerns. The type of information important to research performers is informal communication among peers and methodological information. At this stage, funding agencies and policymakers need information regarding the efficient management of research programs, as well as feedback concerning the successful accomplishment of project goals and objectives. Traditional research is easier to manage than an innovative, groundbreaking approach.

Ultimately the products of research planning and performance are disseminated through formal and informal channels. Funding programs have traditionally supported dissemination through the funding of page charges, translation services, and conference attendance. Still, the bulk of decisionmaking regarding dissemination is in the hands of research performers and the scientific information transfer infrastructure (journals, associations, libraries, databases, etc.) which have developed over the years.

The final stage is utilization. A distinction is made here between dissemination and utilization. Dissemination² refers to the transmission of information to intended (and unintended) users; utilization, on the other hand, describes the receipt and application of that information, coupled with the impact or benefit of utilization. Utilization, by far, is the most difficult stage of research to satisfactorily measure. Whereas one can at least measure dissemination in terms of the physical output of a program --- e.g., the number of papers published --- or in the perceived or ascribed quality of research --- e.g., through peer review or citation analysis of published articles --- utilization requires a much more serious study of actual and potential users. The major difficulties involved in measuring a research program's utilization can be stated quite simply:

1. Much research utilization occurs through accidental awareness of and access to relevant information (e.g., see Austin, 1978).
2. Research, especially basic research, may not be concerned with potential utilization in mind.
3. Neither the researcher performer nor program administration have a direct control of when the information generated by the program may be needed.
4. Highly valuable or beneficial utilization may occur by individuals and groups never considered to be potential users by researchers and program administrators.

Paraphrasing Machlup (1979), utilization can only be said to have occurred when the user's state of knowledge has been altered. In addition, research programs which are problem-oriented, such as those in the areas of health and social welfare, are only truly effective when an alteration of behavior has been accomplished. Without getting into the bias inherent in self-reported measurement regarding changed knowledge or behavior, it is safe to say that research program administrators are usually hard-pressed to know when information generated by their research program alters the state of knowledge or behavior of anyone.

²This definition of "dissemination" is more restrictive than that adopted within the field of educational R&D. For a discussion, see An Overview of State Dissemination Activities (1978).

4. Development of Information Transfer Measures

In order to develop specific measures for use in evaluation, it is first useful to identify the type of questions we would like to ask. In each cell of Table 1 one or two questions are listed which appear to be the main evaluative question to ask concerning a particular research stage and interest group. These are the types of questions which the evaluator or research administrator might ask by focussing on information transfer.

For research performers, the questions under Planning concerning use of relevant and up-to-date information during planning are normally answered during the proposal review cycle through the examination of the proposal's bibliography and discussion of relevant research. These two items are usually taken as evidence that the researcher will not duplicate effort. How effectively this screening takes place depends, of course, on a variety of factors. Not the least of these is the ability of the evaluator to recognize the ability of the researcher to take advantage of relevant information sources. Personnel reputation and/or a review of relevant literature are usually taken as evidence of this. But they may tell the evaluator or administrator little or nothing about the researcher's facility in using personal contacts and other informal information sources. And it is these informal information sources which are universally acknowledged to be paramount in terms of information transfer. However, the works normally acknowledged in a research proposal are theoretically publicly-available items; it is neither the norm nor the practice to advertise one's own communication skills in a research proposal.

Is it possible, then, to identify an indicator or measure which would allow a research administrator to predict whether or not a proposed research performer is an accomplished communicator, without violating confidentiality and privacy norms? Such an indicator would require that the research administrator distinguish between the research performer's past research quality (or future potential, for newcomers) and his or her skill in communicating his findings. The danger of such an approach, of course, is that political skill or a tendency to self-advertise might be given more weight by some evaluators than actual quality or content. Yet the ability to disseminate one's findings are critical if

TABLE 1. MAJOR INFORMATION-RELATED QUESTIONS
RELATED TO RESEARCH PROGRAM EVALUATION

Interest Group	Research Stage			
	Planning	Performance	Dissemination	Utilization
1. Research Performers	1. Have the performers used the most relevant information in the design of the project? 2. Are they aware of what research is currently being conducted?	1. Do the performers continue to monitor relevant ongoing research? 2. Is currently obtained information obtained and applied in the project?	1. Are performers aware of the relevant dissemination channels? 2. Has the information been prepared in a form which is appropriate for the intended audience?	1. Does the performer obtain (and use) feedback concerning research utilization?
2. Other Researchers	1. Do researchers have a mechanism or forum for assessing their own profession's research needs?	1. Are other researchers aware of what progress is being made? 2. Are the other researchers who are aware of research-in-progress likely to use that information?	1. Do other researchers have access to the channels via which research information is disseminated?	1. Do other researchers obtain the information? 2. Do they use the information?
3. Policy-makers	1. How do policy-makers obtain information about the need for research?	1. Do policies exist to encourage the use of various information sources?	1. Do policies exist to encourage the dissemination of research?	1. Do policy-makers obtain feedback on the utilization of research? If so, how?
4. Funding Agencies	1. Does the funding agency provide information to potential performers to aid in the planning process?	1. Are funds provided for the purchase of information?	1. Are funds provided for dissemination? 2. Are performers assisted in selecting and using appropriate channels?	1. Does the funding agency obtain feedback on the utilization of research?
5. General Public	1. How is information concerning public needs & awareness taken into account?	1. Is accurate information provided to the public about what is being performed?	1. What channels are available to the public to obtain research results?	1. Does the public gain practical, useful information from the research?

one expects research to be utilized. An administrator would certainly question the grantee who continually neglects to publish or who makes little or no effort to select appropriate dissemination channels.

It is not uncommon for funding agencies to require that grantees or contractors describe their dissemination plan in terms of articles to be published and papers to be presented. Perhaps the potential research performer's skill in articulating and following through with such a plan should be given much more emphasis when funding is being considered. This is especially important when the research which is funded is potentially useful for non-researchers. Placing more responsibility for at least planning dissemination activities on the research performer may actually reduce the time it takes for innovative research to be adopted.

A final question concerning the research performer concerns whether he or she attempts to follow up on how the information generated in a project is utilized. Some dissemination channels do provide an "informed response" to the performer, such as journals which utilize refereeing, and open forums for discussion, such as conferences. Exclusive use of one-way dissemination channels, such as technical reports, strict formal lectures, or broadcasting, may suggest to the program administrator that the research performer is unwilling or unable to accommodate the scrutiny of peers. This may be especially important when the research output is intended for practitioners, who themselves may possess few formal feedback links with the research community.

The next interest group to consider is other researchers, those working in fields related to the research performer. For basic science research, these other researchers may form the largest single potential user group for the program's information output. For applied research, action research, case studies, and other applications, other researchers may still play an important role, perhaps in terms of judging methodological competency.

Looking at evaluation from the research program level, one relevant question is whether researchers have a mechanism whereby they can assess their own research needs for possible input to the policymakers' and funding agencies'

deliberations. This may seem like placing the burden for identifying research needs on the researchers themselves, a burden which might be thought of as the responsibility of the program management and policy-makers. But it would be naive to assume that there is no political give-and-take between researchers and the funding agencies which "act in their behalf." One of the most direct forms of information transfer which can occur between a field of research and a funding agency is for a researcher to be hired by the agency to work in an administrative or policy-making capacity. Depending upon the researcher's organizational freedom and level of responsibility, the agency thereby obtains a substantial amount of state-of-the-art information.

Another question which is related to other researchers is whether or not they are aware of the research performers' work at the time or shortly after it is conducted. Just as the evaluator should ask if the research performer is competent to disseminate information about ongoing research, the evaluator should also ask if the other researchers in the performer's own field have the means available for finding out about ongoing research. In fields such as experimental physics large groups of researchers associated with major institutions such as Fermilab and Lawrence Livermore find it relatively simple to keep other large groups aware of progress through normal communication via the common channels of mail and telephone. Less concentrated research areas, especially social or problem-oriented areas, may not possess large groups of readily-identifiable peers who might benefit from news of ongoing research.

Some of these same concerns are relevant to the actual dissemination stages of research. It is easier for other researchers to obtain access to information produced by a project if the field has well-established channels and media such as associations, schools, journals, etc. Program evaluation should take this into account when evaluating the effectiveness of dissemination activities.

Perhaps the single most important question which the program administrator can ask is if the research generated by the program's project has been utilized. Not the least of these concerns is the difficulty in defining what is meant by "the use of information." It is one thing to identify the type of application a

researcher might make of information obtained from a particular conversation, lecture, or document. It is another thing to measure the benefit or impact of that application. And it is only in a minority of cases where one can make a convincing numeric statement concerning such a benefit or impact.

To be realistic about the measurement of use of information by other researchers, it is useful to think of utilization as occurring over a series of stages.

First, the researcher becomes aware of the existence of a particular information source. Second, the researcher obtains physical access to the particular medium or channel which provides the source. Third, the researcher reads or otherwise senses the information. Fourth, researcher internalizes and possibly even takes action upon the information. As mentioned earlier, it is unlikely that the program administrator will ever know how the information generated by the program is utilized. Even literature citation measures do not give a direct evidence of the manner in which information is utilized. But it would be valuable for program administrators to at least attempt to measure, preferably on a probabilistic survey basis, the extent of distribution and physical access to program-generated information. On this point, several questions come immediately to mind, such as:

- What are the physical distribution channels available for dissemination?
- How many people have access to these channels?
- How many physical information-bearing documents have been distributed? How many have been distributed on the request of potential users?
- What are the characteristics of the people who have access to the program's information? What are the characteristics of those who state that they have used or applied the information?

By themselves, these are very simple questions, much simpler and less ambiguous than attempting to quantify the value or benefit of a particular research program. Answering them, though, is not necessarily simple, partly because of the cost, but also partly because much of the intellectual attention and prestige associated with research is attached to creation, not to dissemination and utilization. This may be a very tough barrier to overcome when the efficiency of modern information storage and retrieval techniques provide access to original literature long after it is produced.

The third group to consider in the evaluation of information transfer measures are the policy-makers, those who are responsible for setting goals and priorities for the research program. Since their input is most important at the planning stages of the program, it is reasonable that their information transfer behavior at this stage is of most interest to us. In addition, the types of policies that they set can have profound effects on information transfer behavior at the individual project level.

At the Planning stage, one question we can ask is how policy-makers obtain information to set research priorities? Are these decisions based on political considerations? On informally-or formally-developed consensus? Or have attempts been made to obtain information from a broader population to assess research needs? If the needs of a broad population are addressed, are the methods used to generate information about these needs truly representative and unbiased?

Regarding policy-making at the other research stages, the potential impacts should not be underestimated. For example, does the program have stated policies concerning requirements for publication? Are policies stated concerning the purchase of information products and services during the course of the project? Do the stated policies have any potential conflict with policies concerning the provision of information services by other organizations? Federal agencies, for example, are required to make some of their information publishing and disseminating activities self-sufficient (King and McDonald, 1980). Will this affect how the research program operates by constraining how its output is disseminated?

The funding agencies themselves, of course, are in direct control of the research program. While much of the information they need about the research program is management-and budget-oriented, it is they who must allocate the funds for information expenditures such as books, journals, reports, publication activity, literature searches using online retrieval systems, and computer time. In addition, information as described above regarding performers and researchers is especially important.

Finally, we come to the general public, those people who must pay for and ultimately apply the information generated by the research program. Above all, the public should be kept informed of the activities being conducted by the researchers. This may involve a significant public relations effort. The National Science Foundation, for example, funds activities relating to the public understanding of science, including such activities as television and radio programs. Recent attention given in the popular media to interferon and the insulation problems of the space shuttle in the popular media are continuing evidence that channels already exist for getting scientific and technical information to the public.

5. Summary

Briefly, this paper can be summarized as follows.

First, information transfer is one of the most significant activities engaged in by a research program.

Second, focussing on information transfer can provide substantial insight for the research program evaluator and administrator.

Third, focussing on information transfer measures will require thinking about the several interest groups and the different stages of research involved. Above all, it is desirable not to focus only on information output measures but also on how information is involved in the planning and performance stages of research.

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